NASA SUSPENDED LOAD OPERATION ANALYSIS/APPROVAL

OPERATIONS - To hoist the pallet experiment access bridge or the test stand access bridge in the Operations and Checkout (O&C) Building.

SUPPORTING DOCUMENTS - The associated operational procedure and System Assurance Analysis (SAA) are as follows:

- OMI L5130 (Rev B, 03/23/90), Multipurpose Hoisting
- SAA01FS027-002 (Rev A, 07/26/88), 27.5 Ton Bridge Cranes - O&C

GENERAL DESCRIPTION - The task below requires one person to be under the suspended hoist beam to attach cables to the platforms as follows:

- OMI L5130, Work Platforms and Miscellaneous Items Hoisting

Pallet experiment access bridge and test stand access bridge hoisting operations are performed in the O&C low bay using one of the 27.5 ton bridge cranes. The technician has to reach up under the suspended hoist beam to attach the links, snap hooks, and sling assemblies to the crane hook and to the lifting eyes and fittings of the bridge.

RATIONALE/ANALYSIS - The suspended load tasks comply with the NASA Alternate Safety Standard as follows:

Alternate Standard Requirement #1a - These operations cannot be conducted without one technician reaching up under the suspended hoist beam, which is wider than the bridge, to make the attachments. Pallet experiment access bridge and test stand access bridge hoisting operations in the O&C have been evaluated, and it has been determined that there are no procedural or operational means to eliminate exposure to a suspended load because of the size of the hoist beam, which is suspended over the bridge while making the connections for the lift.

Operationally, the shackles have been replaced with snap hooks to minimize technician exposure time under the load while making hardware connections.

Because the hoist beam must be positioned over the bridge to access the inboard
attach points for connnections, there are no feasible design changes that preclude working under the suspended hoist beam.

If the hoist beam were to fall while the technician is attaching the pallet experiment access bridge hoist cables, the upper bridge structure may stop or deflect the hoist beam and allow the technician time to get out from under the suspended load.

If the hoist beam were to fall while the technician is attaching the test stand access bridge hoist cables, the handrails would protect the technician from the falling hoist beam.

Alternate Standard Requirement #1b - The possible use of a secondary support system, to catch the load in the event of a crane failure, was analyzed. It was determined that the use of a secondary support system was not feasible because of positioning of the pallet experiment access bridge or the test stand access bridge over the test stand.

Alternate Standard Requirement #1c - The maximum number of personnel allowed under the suspended hoist beam during hoisting of the pallet experiment access bridge or the test stand access bridge is one.

Alternate Standard Requirement #1d - Pallet experiment access bridge and test stand access bridge hoisting operations will be accomplished as quickly and safely as possible to minimize exposure time. It will take one person 5 minutes to attach the associated equipment under the hoist beam.

Alternate Standard Requirement #4 - OMI L5130 has been revised to permit only the approved number of persons under the suspended hoist beam. The OMI is available on site for inspection during the operation.

Alternate Standard Requirement #6 - Suspended load operations associated with hoisting the pallet experiment access bridge or the test stand access bridge in the O&C involve one of the 27.5 ton bridge cranes. The cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9.

The 27.5 ton crane hoists are equipped with two magnetic holding brakes (one on the motor shaft and one on the gear reducer input shaft extension), each capable of holding the load up to the crane's rated capacity. Each brake's ability to hold the rated load (27.5 tons) is verified annually. The cranes are designed to meet a 5 to 1 safety factor based on ultimate strength for the hoist load bearing components.

One of the 27.5 ton cranes is being utilized for these tasks. The weight of the load is 6,000 lbs, which is 5.5% of the crane's capacity.

The lifting sling is rated at 6,250 lbs and is designed to meet a 5 to 1 safety factor based on ultimate strength.

The 27.5 ton cranes are load tested annually at 100% of their rated capacity. Detailed preventive maintenance is performed monthly, quarterly, semiannually, and annually on the cranes to ensure proper operation. A detailed inspection of the lifting slings is performed annually. Nondestructive testing of the slings and crane hooks is performed annually.

Alternate Standard Requirement #7 - A System Assurance Analysis (SAA) has been completed on the 27.5 ton bridge cranes in the O&C. The SAA includes a failure modes and effects analysis/ critical items list (FMEA/CIL) and a hazard analysis (see supporting documents).

The SAA identifies one single failure point (SFP), the hoist gear reducer, which transmits power and reduces rotational speed from the hoist motor to the rope drum. A sheared key or broken teeth would cause interruption of the load path at the gearbox. This failure would result in the load dropping, which could cause loss of life and/or payload.

There is no history of failure with the SFP in the critical failure mode. A detailed inspection of the gear reducer is performed monthly, and gear reducer oil samples are verified annually. The use of high-quality, reliable components and a comprehensive maintenance, inspection, and test program (including preoperational checks) ensures that the crane systems operate properly.

The associated SAA CIL Sheets (pp. 62 and 63) identify all the rationale for accepting the risk of the SFP including design information, failure history, and the operational controls in effect to minimize the risks (maintenance, inspection, test, etc.).

Alternate Standard Requirement #8 - Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks, hoist beams, hoist cables, hoist rod assemblies, and hoist fittings, and crane functional checks are performed before each operation per NSS/GO-1740.9.

Alternate Standard Requirement #9 - Trained and licensed crane operators shall remain at the hoist controls while personnel are under the load.

Alternate Standard Requirement #10 - Appropriate safety control areas are established before initiating operations. Only the minimum number of people (manloaded in the procedure) will be permitted in this area.

Alternate Standard Requirement #11 - A pretask briefing and a safety walkdown of the area are conducted prior to the lift to ensure that all systems and personnel are ready to support. All participants are instructed on their specific tasks and warned of any hazards involved. Following any crew change, the new personnel are instructed by the task leader on their specific tasks and warned of any hazards involved.

Alternate Standard Requirement #12 - Personnel beneath the suspended load will be in voice contact with the hoist operator/ task leader. Upon loss of communication, the operation shall stop immediately, personnel shall clear the hazardous area, and the load shall be safed. Operations shall not continue until communications are restored.

Alternate Standard Requirement #13 - Personnel working beneath the load shall be in continuous sight of the hoist operator/task leader.

APPROVAL: DATE: CONCURRENCE: DATE:

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